Space Weather Technical Forecast

Issued on Friday 8 November 2024 at 13:20 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate solar activity with a chance of X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with several M-class flares. A peak flare of M2.3 was observed at 07/1506 UTC from the vicinity of AR3883.

There are currently eight sunspot regions on the visible disc. The three most actively flaring regions (AR3883, AR3886 and AR3889) all lie in the southern hemisphere, but close to the solar equator. AR3883 (Fki/Beta-Gamma-Delta), in the south-centre disc has continued to elongate and shear in the central portion whilst maintaining a small, but well-defined, delta spot. AR3889 (Eki/Beta-Gamma-Delta), in the far southeast appears to be a moderately-large group with a cluster of mature spots. Although foreshortening reduces confidence in determining the group's magnetic configuration, a delta spot remains apparent in the trailing portion. AR3886 (Eai/Beta-Delta), to the east of AR3883, is a broad group both longitudinally and latitudinally consisting of a few mature spots and numerous faint spots. This region retains a very small delta spot, but is otherwise decaying. The remaining sunspot regions are smaller and more magnetically simple and generally either stable or in decay.

A CME that left the Sun on 05 Nov, may have given Earth a very slight and glancing blow around 08/1030 UTC. No Earth directed CMEs (Coronal Mass Ejections) were observed in available imagery. A number of dimming events have been observed 07-08 Nov near centre disc, in the vicinity of AR3883 and AR3886. Available coronagraph imagery would suggest that no ejecta was released during these events.

Solar Wind / Geomagnetic Activity: Solar winds as measured at L1 by ACE/DSCOVR were initially at slightly elevated levels of 400-420 km/s following CME enhancement on 07 Nov. Winds gradually declined to background by around 07/1900 UTC and were steadily around 350 km/s for much of the period. Since 08/1030 UTC a slight uptick in winds has been observed, with speeds now around 380 km/s. This has been attributed to a potential glancing blow from a CME that left the Sun on 05 Nov.

Density was above following yesterday's CME arrival, reaching a peak of 46 ppcc at 07/1529 UTC. This observation seemed somewhat spurious, with around 25 ppcc more representative of density at that time. Late evening the density rapidly decreased, ending the day at average levels. Since around 08/0400 UTC density increased once more, reaching a peak of 33 ppcc at 08/0739 UTC.

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Density has recently decreased but remains above average. The Interplanetary Magnetic Field (IMF), Bt, was predominantly weakly, but reached moderate levels (8 nT) between 07/1738-2218 UTC. The IMF has strengthened since around 08/1000 UTC and is currently strong with a peak of 16 nT at 08/1159 UTC. The north-south component, Bz, was mostly weakly negative, reaching - 6nT at 07/1755 UTC. Since 08/0000 UTC, Bz has been weakly positive, peaking at moderate levels of +13 nT towards the end of the period. Phi angle was generally positive but has been negative (towards the Sun) since 07/2330 UTC. Geomagnetic Activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 remained at background levels. High energy electron flux (greater than 2MeV) observed by GOES16 was at background to Moderate levels for much of the time, but temporary increased to reach High levels, peaking at 1292 pfu at 07/1650 UTC. The associated 24-hour fluence was well below the Active threshold, with 1.5e7 integrated flux observed at 08/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is forecast to continue, with occasional M-class flares expected and a chance of isolated X-class flares, with AR3883 and AR3889 currently the most likely sources.

Solar Wind / Geomagnetic Activity: A minor CME enhancement is currently being observed at Earth following a glancing blow, with any influence waning by the end of Day 1 (08 Nov).

Solar winds are currently at normal background levels. A weak HSS enhancement is considered probable later today (08 Nov) or during Day 2 (09 Nov), with Slightly elevated wind speeds at peak. This may be masked by the slight enhancement from the CME glance. There is a chance for further possible HSS influence to bring Slightly elevated or Elevated levels later Day 2 or Day 3 (10 Nov) from a larger but much more southerly located coronal hole.

Mainly Quiet to Unsettled (Kp 1-3) activity is expected, but with isolated Active (Kp 4) intervals possible due to the combination of HSS and CME influences.

Energetic Particles / Solar Radiation: High energy proton flux at GOES-18 is at normal background levels. There is a slight chance of S1/Minor Proton Storms or greater on Days 1-2 (08-09 Nov), rising to a chance from Day 3 (10 Nov) as the significant regions on the visible disc rotate into more geoeffective positions. The high energy electron flux is expected to be mainly Background to Moderate initially, later increasing to mostly Moderate levels and perhaps temporarily touching High levels at the peak of diurnal cycles. The associated fluence is excepted to persist below Active levels.

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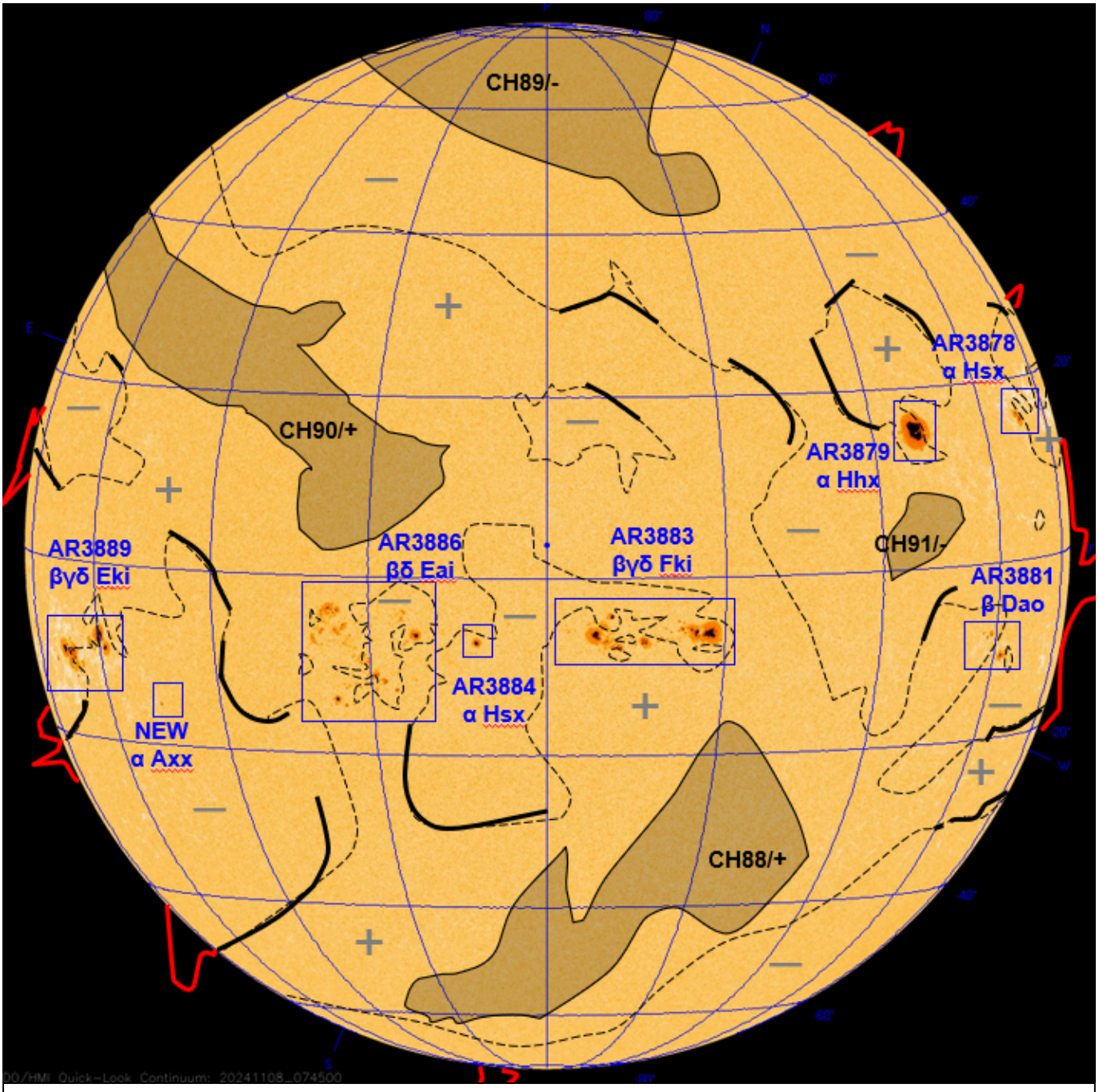
Figure 1: Solar Synoptic Map valid 08/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Solar Orbiter detected a moderate CME enhancement around 07/0400 UTC. The current location of the satellite is 7 degrees East of the Earth-Sun line at 0.71AU and therefore could provide useful insight into any potentially Earth-directed CMEs. Based on previously modelling it is considered likely that this feature is related to the lift-off associated with mid-high level C-class flaring of AR3883 around 05/0000 UTC. Disturbances in the solar wind parameters around 08/1030 UTC suggest that this is the anticipated glancing blow. No further CME arrivals currently feature in the forecast, however a number of long and large filaments could disrupt, and act as a source for Earth-directed CMEs later in the period.

Small equatorial coronal hole CH91/- in the western disc may give some weak enhancement in solar winds later today (08 Nov) or through Day 2 (09 Nov), but as this is a non-recurrent feature confidence is moderate at best. Slightly elevated solar wind speeds are considered most likely from this feature around 400-450 km/s. Only limited Geomagnetic effects are expected, given that it is a negative polarity coronal hole.

MOSWOC's ENLIL model shows significant enhancement from CH88/+ HSS influence to Elevated levels. This is considered far too strong and too early. The coronal hole is positioned quite far south on the disc with no significant connection expected. If a connection were to occur then this may happen late Day 2 (09 Nov) or early Day 3 (10 Nov), bringing slightly elevated to elevated solar wind speeds. SWPM also provides a poor steer due to CME contamination on the last rotation.

Mainly Quiet to Unsettled (Kp 1-3) activity is expected, but with isolated Active (Kp 4) intervals likely due to occasional weak HSS and CME influences. Slight chance of G1/Minor (Kp 5) geomagnetic storm intervals until late Day 3, but this is considered low confidence.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	15	20	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
2024-11-05 00:01	Partial	AR3883	SE	606	Late 07 or early 08 Nov	Glancing blow considered to have arrived around 1030 UTC. Aligns with Solar Orbiter projection of arrival.

Figure 2: MOSWOC Enlil. Wind speeds currently 100-200 km/s too fast.

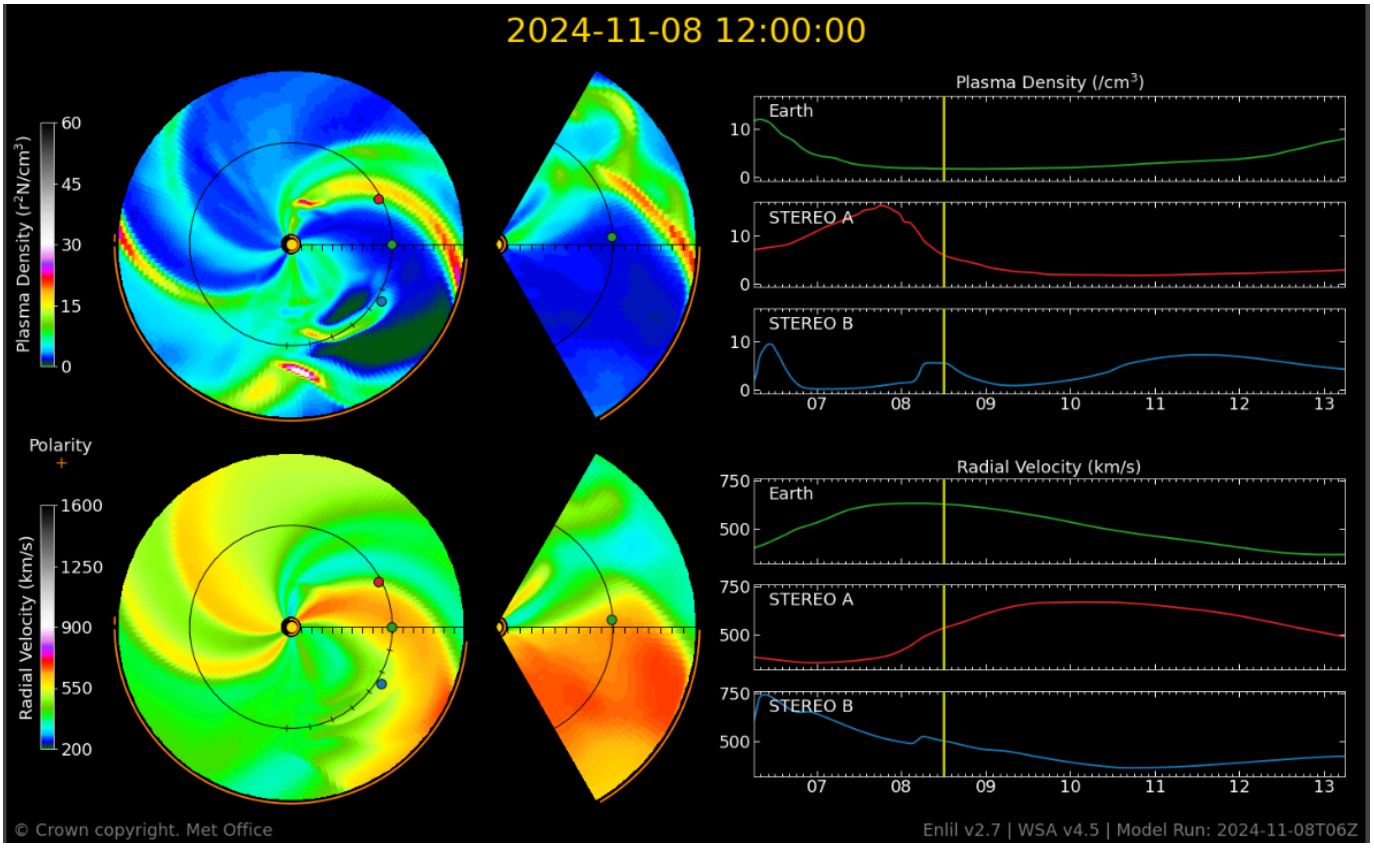

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Figure 3: MOSWOC Enlil ensemble showing uncertainty during 08-09 Nov.

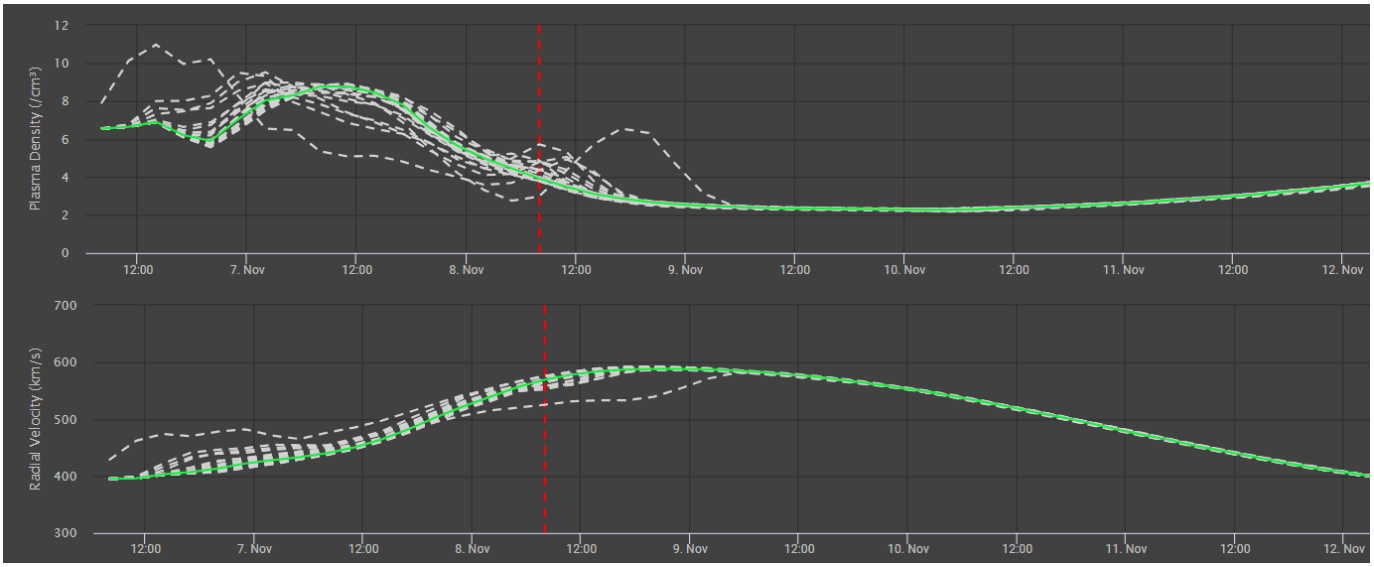

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Figure 4: SDO AIA/211 Imagery showing the strong but southward location of CH88/+. The coronal hole in the eastern hemisphere is not expected to have any influence until after the forecast period.

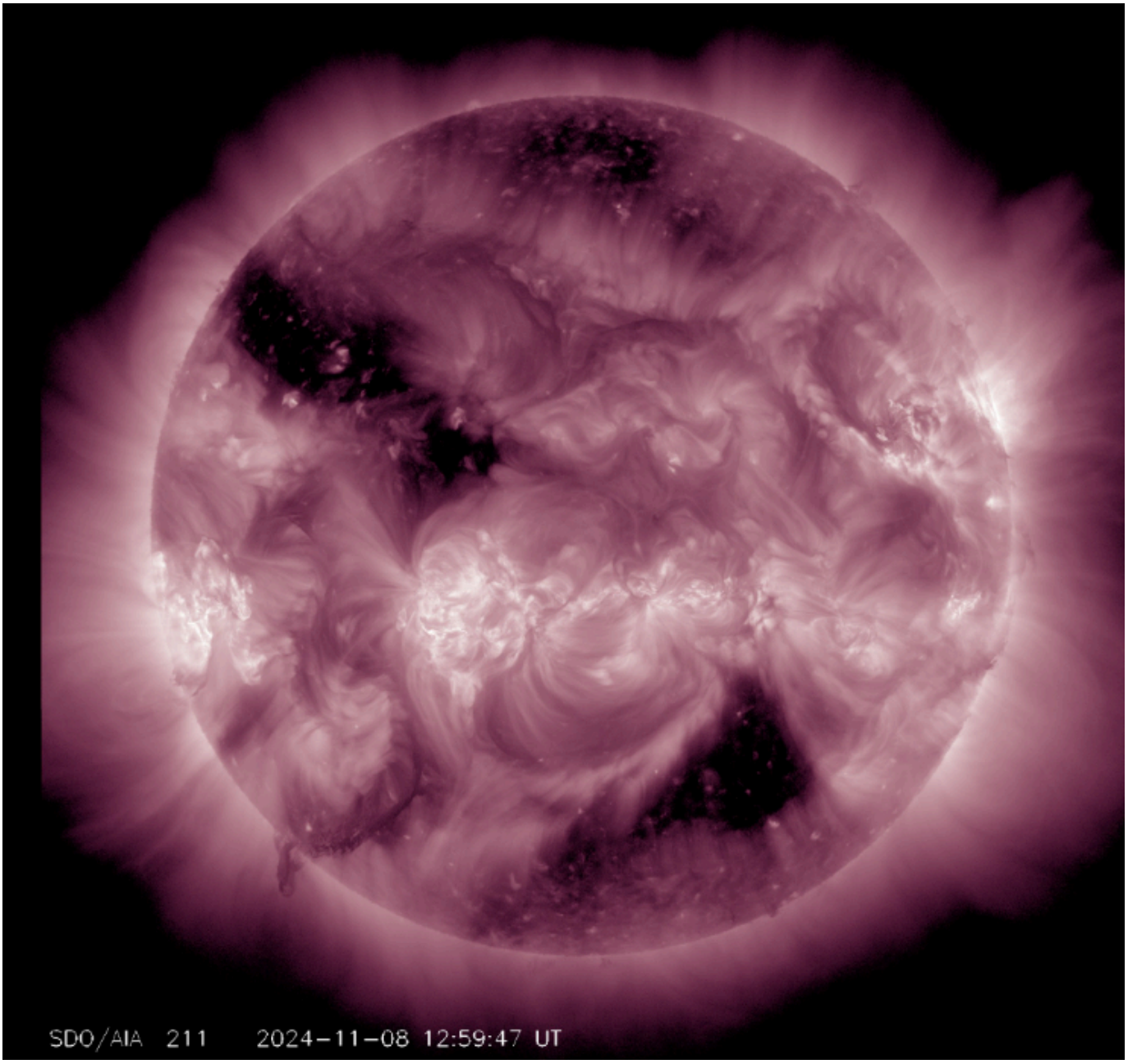

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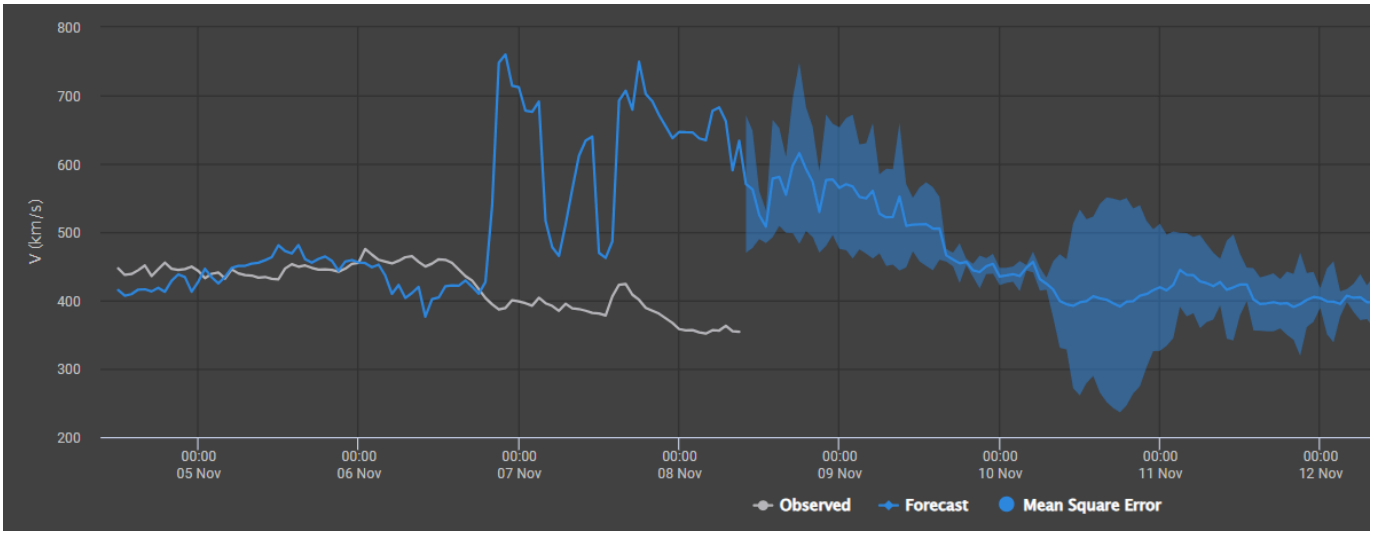
Figure 5: SWPM providing poor guidance in wind speeds until later in period.



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Radio Blackouts - X-Ray Flares

There are currently eight numbered sunspot regions on the visible disc, including one unnumbered group. AR3887 departed the disc earlier on 08 Nov.

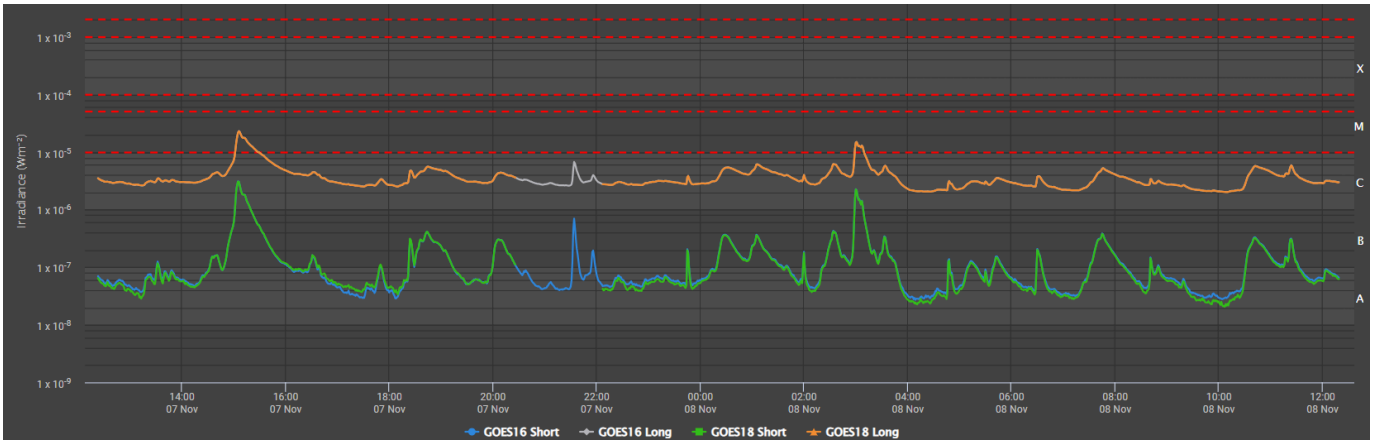
AR3879 is the largest region on the disc, and is a simple Hhx in the northwest. AR3883, in the centre-disc, has seen some shearing and elongation of the central portion, leading to the classification as Fki/Beta-Gamma-Delta. A small but well defined delta spot is present on intermediate spot. AR3886, to the east of AR3883, consists of several clusters of spots and extends longitudinally and latitudinally. This spot has developed a small delta spot in a northern trailing portion, while a slight decline in area continues with many spots fading towards pores. AR3889 (Eki/Beta-Gamma-Delta) in the southeast appears as a moderately-large group with a cluster of mature spots. The region is becoming clearer as it rotates further onto the visible disc, and appears to have a strong delta spot within a trailing portion of the region. The remaining spot regions are smaller and more magnetically simple, generally either stable or in decay.

A new region may emerge across the eastern limb during Days 1-2 (08-09 Nov), but no significant arrivals or departures are expected during the period.

Moderate activity is forecast to continue, with occasional M-class flares expected and a chance of isolated X-class flares, with AR3883 and AR3889 currently the most likely sources.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	20	20	20	20

Figure 6: GOES16 and GOES18 X-Ray Irradiance trace over past 24 hours.



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Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES-18 is at normal background levels. Many of the notable sunspots that currently occupy the Earth-facing disc are located in centre disc or the eastern hemisphere. Some modest proton enhancement was observed by ACE at L1 earlier on Day 1, likely associated with the passage of a CME. However, no such response has been recorded at Earth. There is a slight chance of S1/Minor Proton Storms or greater on Days 1-2 (08-09 Nov), rising to a chance by Day 3 (10 Nov) as the significant regions rotate into more geoeffective positions in the western hemisphere

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	20	25
Very Active	**≥ S3 ***	No	1	1	1	0
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background to Moderate levels, having briefly reached High levels on 07 Nov at the peak of the diurnal cycle.

The high energy electron flux is expected to remain at Background to Moderate at first, then increasing to predominantly Moderate levels later in the forecast period, perhaps temporarily touching High levels at the peak of diurnal cycles later in the period, due to HSS influence. The associated 24 hour fluence is expected to persist below Active levels, which corresponds with the guidance shown in the MOSWOC REFM output. Therefore the REFM model is considered to be showing reasonable guidance, although an increasing trend is preferred.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	5	10	20
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 7: GOES16 Electron trace

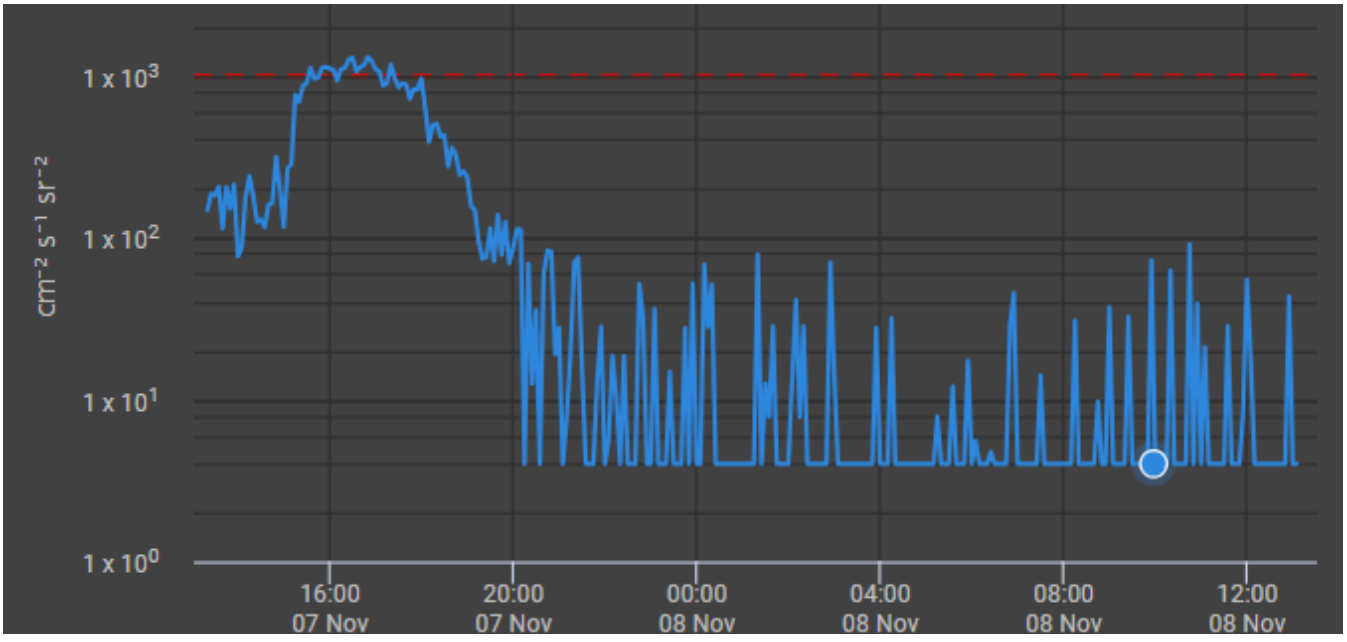

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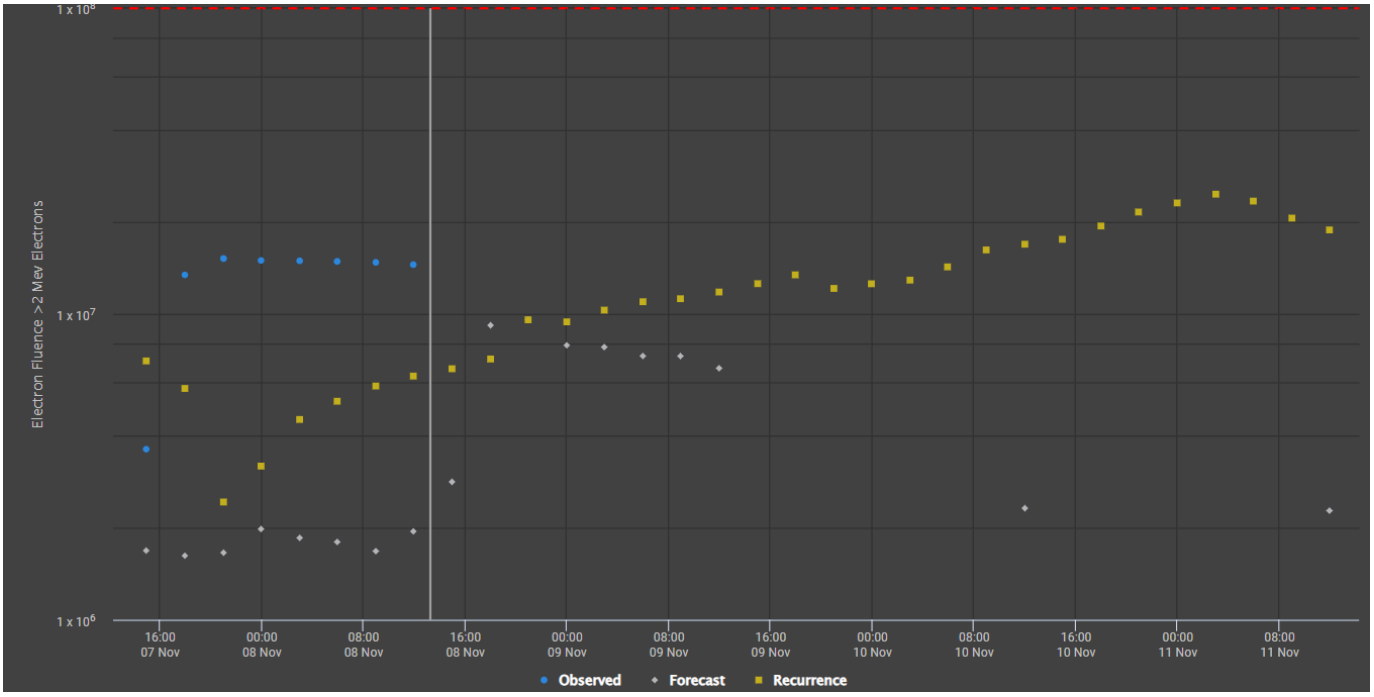
Figure 8: MOSWOC REFM



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